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Taylor

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(54) **INTERPOSER PLATE**

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Related U.S. Application Data

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(51) **Int. Cl.**

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H01R 13/24	(2006.01)
H01R 43/16	(2006.01)
H01R 13/41	(2006.01)
H05K 7/10	(2006.01)
H01R 12/70	(2011.01)

(52) **U.S. Cl.**

CPC ***H01R 13/24*** (2013.01); ***H01R 43/16*** (2013.01); ***H01R 13/2442*** (2013.01); ***H01R 13/41*** (2013.01); ***H05K 7/10*** (2013.01); *H01R 12/57* (2013.01); *H01R 12/7076* (2013.01)

USPC **439/66**

(58) **Field of Classification Search**

USPC 439/66, 91, 81, 71, 65, 886

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,464,007	A *	8/1984	Parmer	439/389
4,647,124	A	3/1987	Kandybowski	
4,762,507	A *	8/1988	Rudy et al.	439/595
5,094,634	A	3/1992	Dixon et al.	
5,571,033	A *	11/1996	Kinsey et al.	439/595
6,358,068	B1	3/2002	Houtz	
6,528,984	B2 *	3/2003	Beaman et al.	324/755.08
6,776,624	B2 *	8/2004	Suematsu	439/71
6,945,788	B2	9/2005	Trout et al.	
6,971,885	B2 *	12/2005	Mowry	439/66
6,981,879	B2 *	1/2006	Kuczynski et al.	439/66
7,044,746	B2	5/2006	Copper et al.	
7,059,869	B2	6/2006	Wertz et al.	
7,083,429	B2	8/2006	Hashimoto et al.	
7,147,489	B1	12/2006	Lin	
7,263,770	B2	9/2007	Mendenhall et al.	
7,291,021	B2	11/2007	Shirai et al.	
7,297,007	B2	11/2007	Hao	
7,322,829	B2	1/2008	Ma	
7,645,164	B1 *	1/2010	Ju	439/591
7,674,114	B2 *	3/2010	Tanaka et al.	439/74
7,695,288	B2	4/2010	Ma et al.	
8,147,256	B2	4/2012	Jin	
8,385,079	B2 *	2/2013	Choi et al.	361/783
8,741,667	B2 *	6/2014	Hembree et al.	438/15
2002/0022383	A1 *	2/2002	Sakata et al.	439/66
2014/0045350	A1 *	2/2014	Taylor	439/66

* cited by examiner

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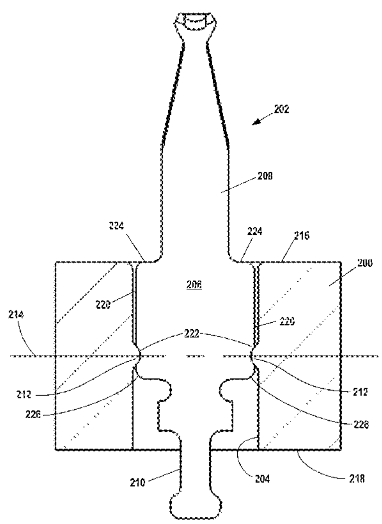
(57) **ABSTRACT**

The disclosure relates to interposer assembly plates with large numbers of closely spaced contact apertures extending through the plates and contact members inserted into and retained in the apertures.

23 Claims, 7 Drawing Sheets



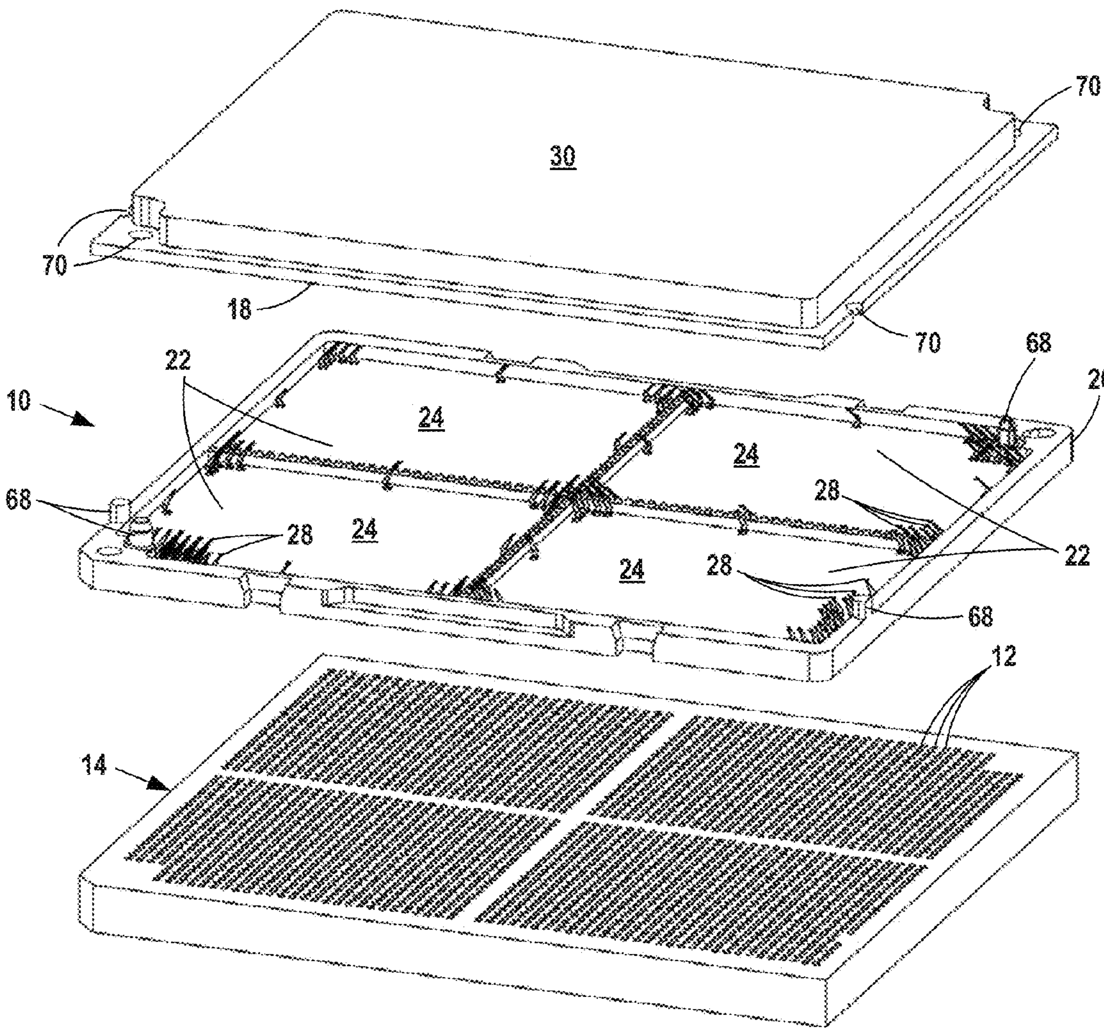


Fig. 1

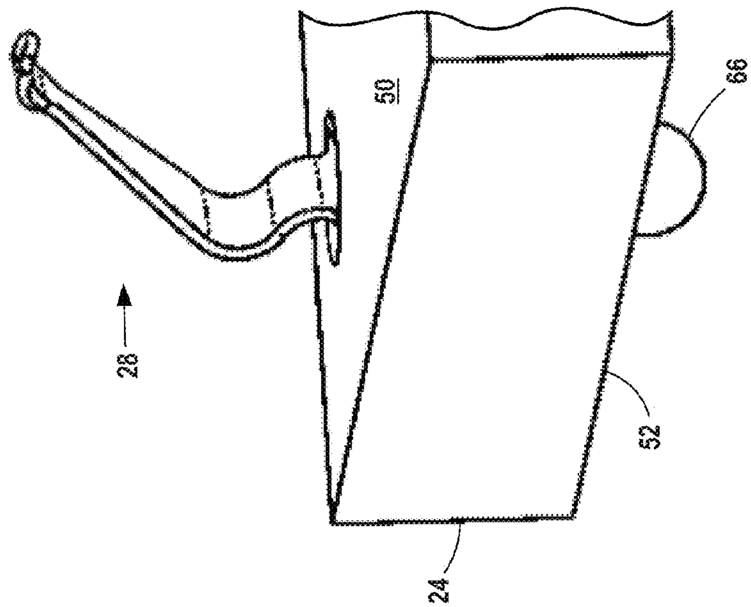


Fig. 3

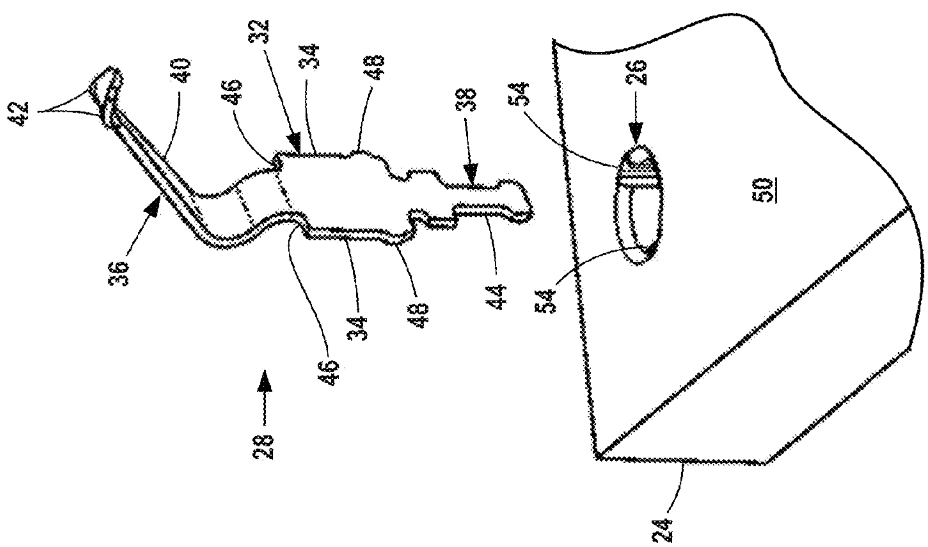


Fig. 2

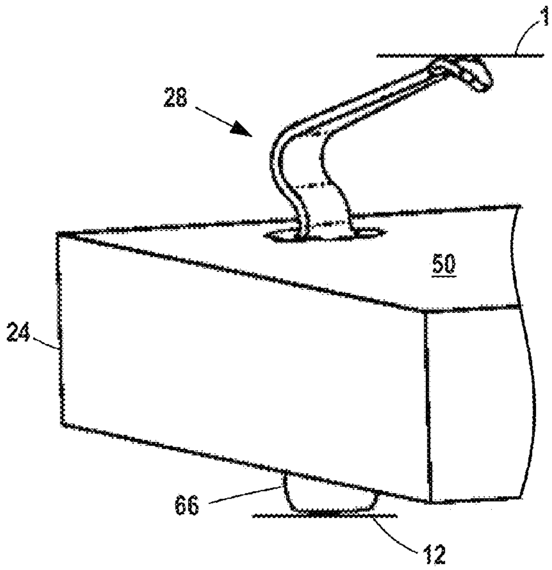


Fig. 4

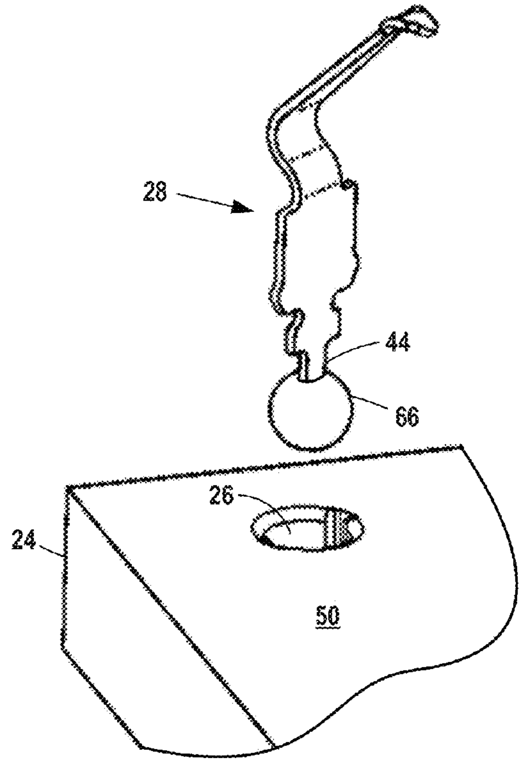


Fig. 6

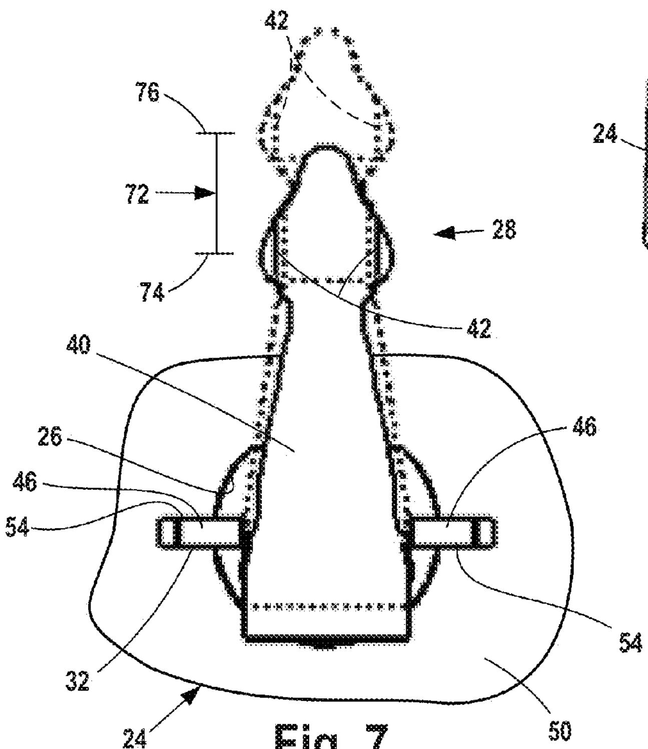


Fig. 7

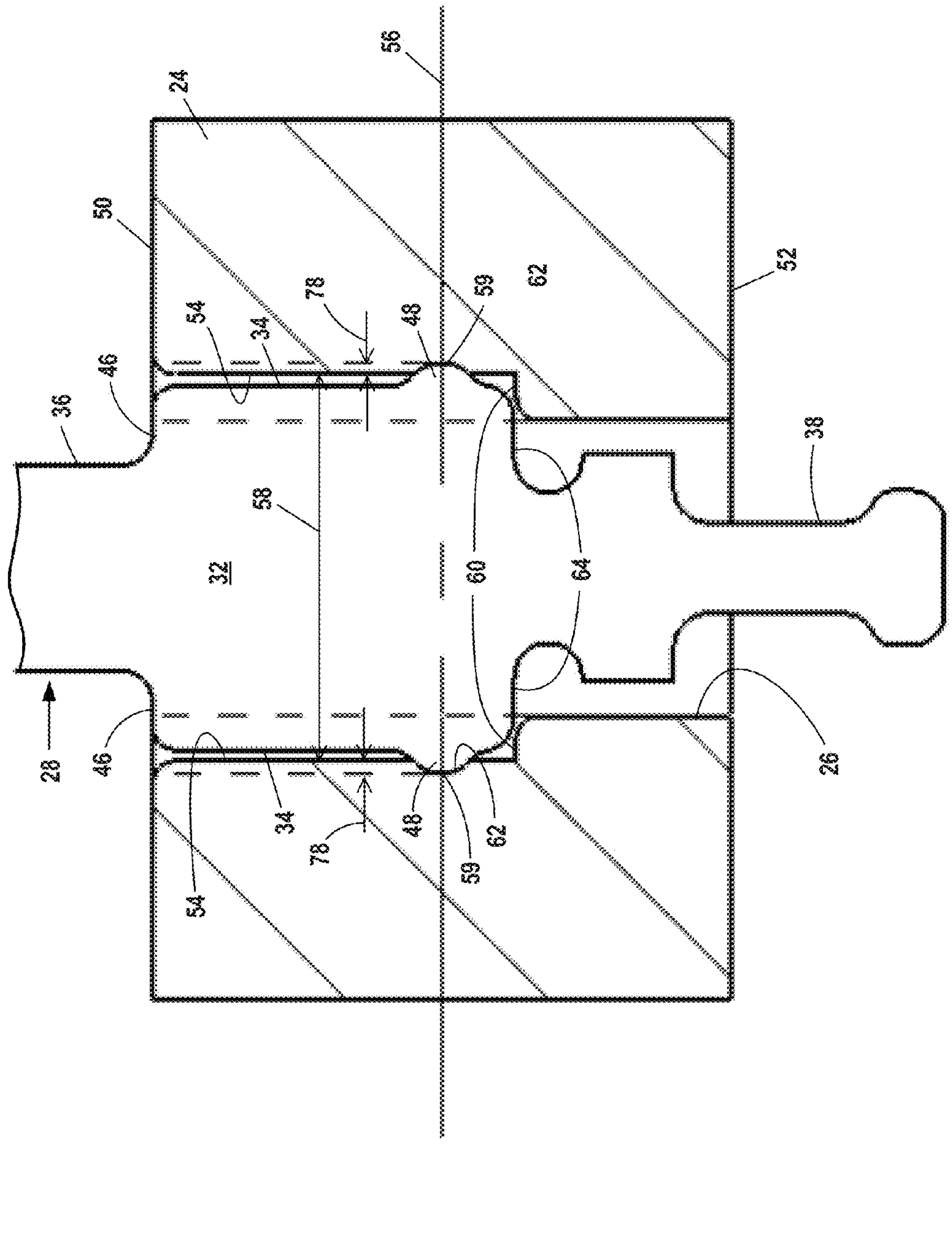


Fig. 5

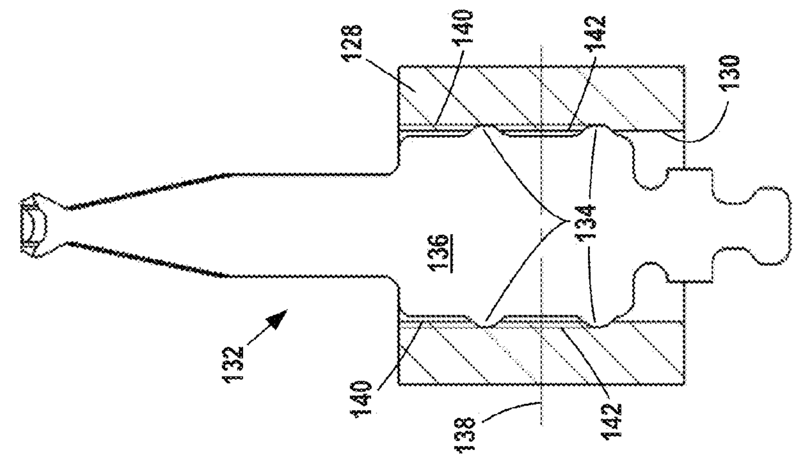


Fig. 10

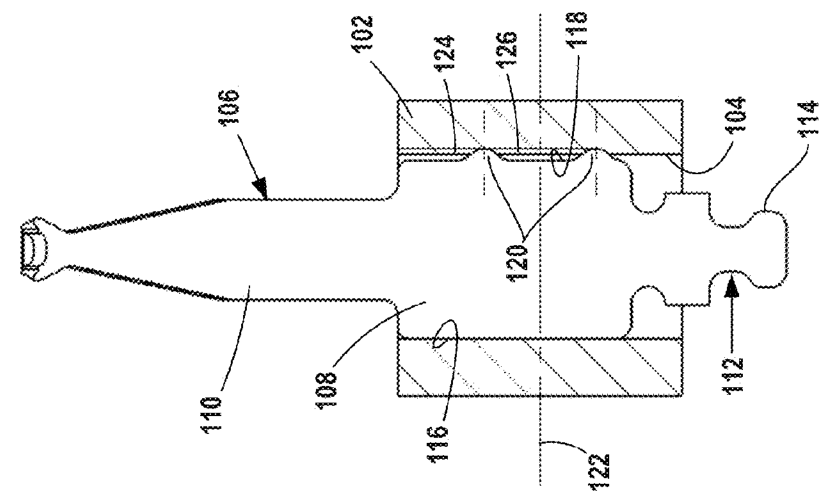


Fig. 9

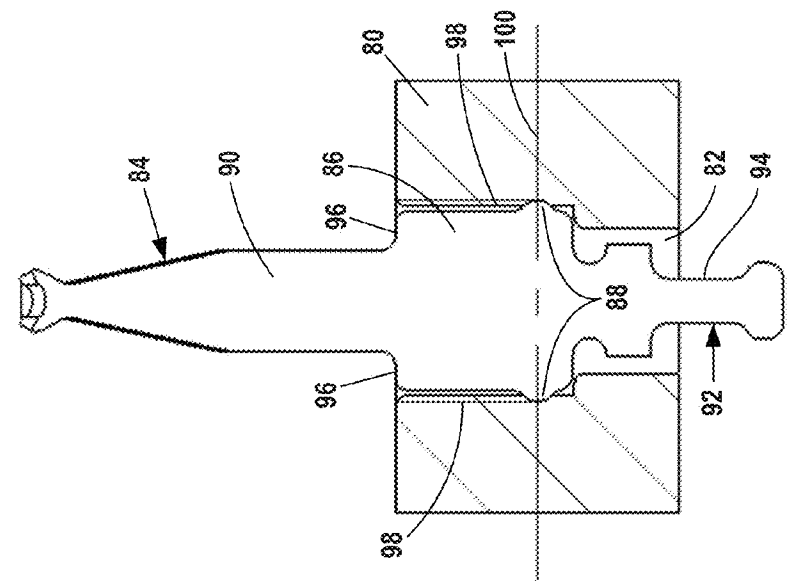


Fig. 8

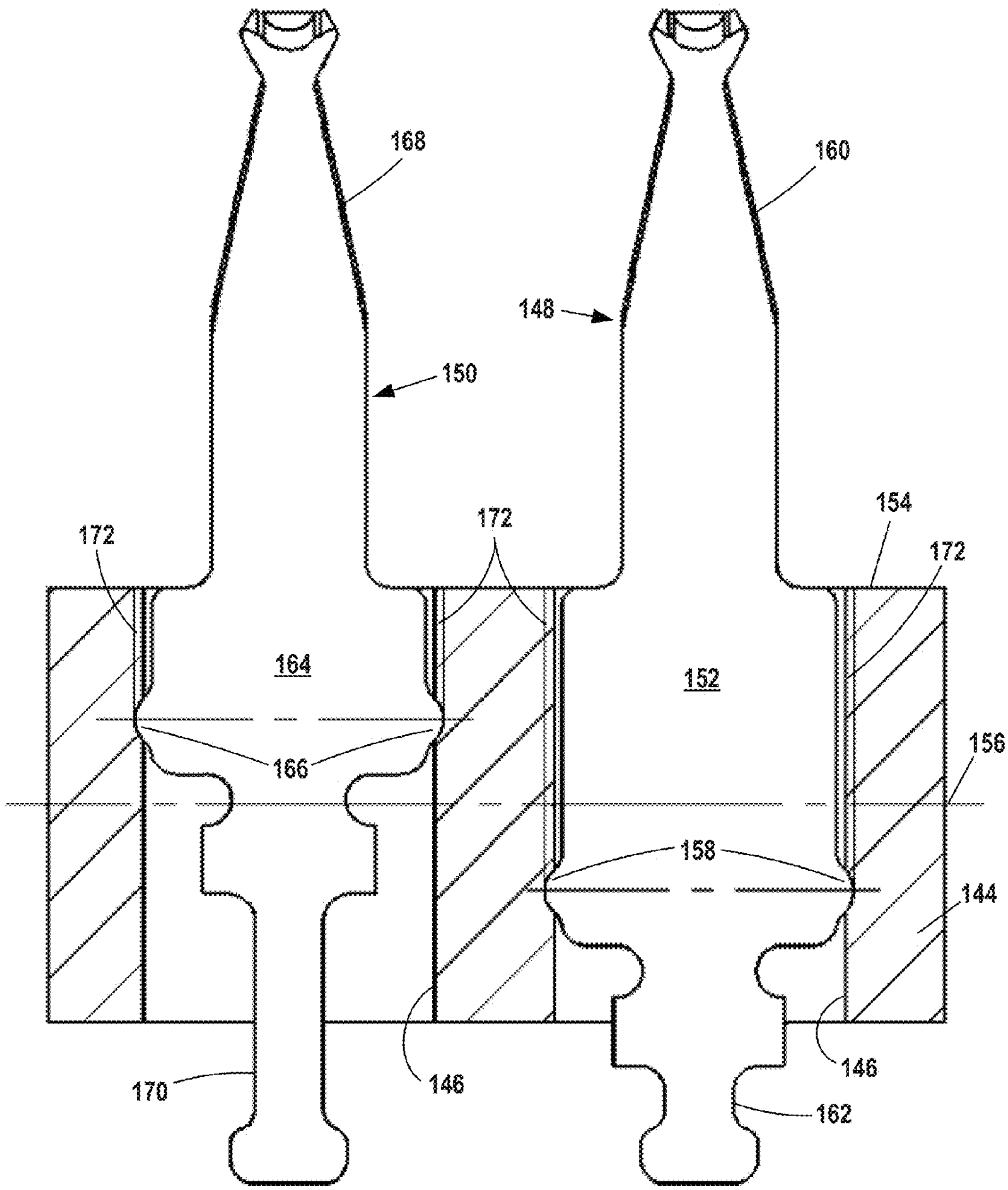

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Fig. 11

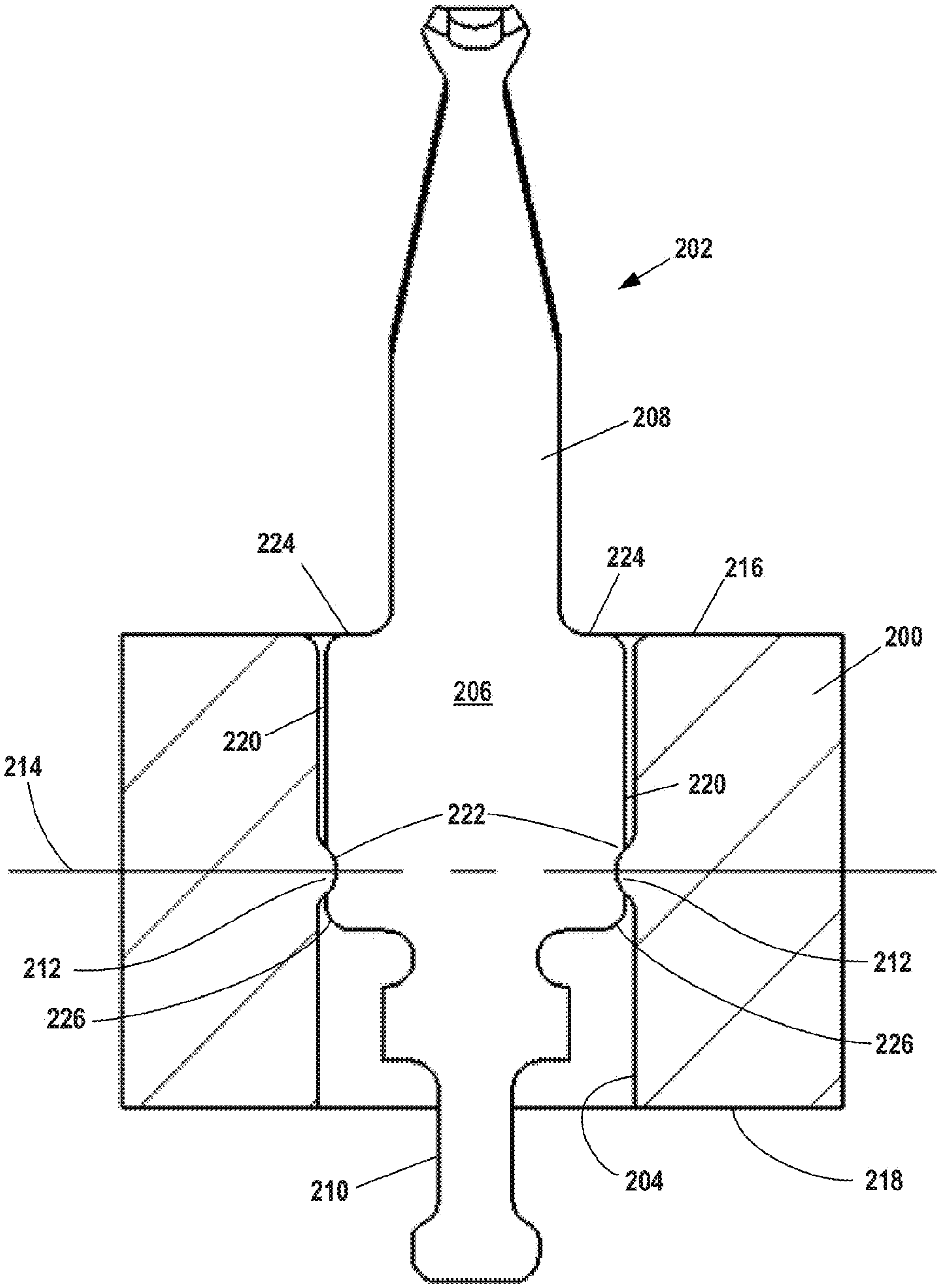
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Fig. 12

INTERPOSER PLATE

BACKGROUND OF THE DISCLOSURE

Interposer plates with inserted metal contact members in apertures extending through the plates are used for forming electrical connections between contact pads on opposed substrates.

The pads on the substrates and the contact members are typically arranged in closely spaced rows and columns. Each plate may support 3,000 or more contact members. The contact members are inserted in the apertures and must be held in known positions in the apertures in order to assure proper engagement with pads on the substrates and to permit attachment of solder balls. The contact members must be supported in the plates in known locations during attachment of solder balls, during reflow soldering of attached solder balls to form electrical connections with pads on an underlying substrate and during stressing of spring contacts on the contact members to form electrical connections with pads on substrates.

The close spacing of the contact members means there is limited space in the plate for forming physical connections between the plate and contact members inserted in through apertures.

The connections between the contact members and the plate should permit withdrawal of a contact member when the contact member is deformed or needs to be replaced and should permit reinsertion of another contact member in the same aperture.

Also, connections between the contact members and the plate must not bow or vary the shape of the plate. Bowing of the plate alters the vertical positions of contact members in the plate and makes it unsuitable for attachment of solder balls to solder tabs and unsuitable for soldering on a substrate. Additionally, bowing the plate results in unacceptable uneven stressing of cantilever contacts on contact members in the plate and impairs electrical connections between cantilever contacts and substrate pads.

SUMMARY OF THE DISCLOSURE

An improved interposer plate and method for making an interposer plate are disclosed. Contact members are inserted into closely spaced contact apertures in the plate. The contact members have one or more protrusions or recesses which elastically stress resin in the plate during insertion. The elastically stressed resin engages the inserted contact members and forms connections holding the contact members in the apertures.

During insertion of a contact member into an aperture, and during possible withdrawal of a contact member from the aperture and insertion of a replacement contact member, a protrusion or recess on the member moves along a resin band extending along the side of the aperture. The resin in the band is compressed by the moving contact member. When the contact member is fully inserted, the resin in the band partially returns to its original molded shape. There is sufficient elastic recovery in the compressed resin at the protrusion or recess to form a connection retaining the contact member in position during shipping and placement for soldering. Once all contact members are soldered to pads on a substrate, the contact members are robustly retained in position by solder connections at the substrate. The compressed resin at the protrusions or recesses holds the plate on the contact members.

The resin elastically stressed by protrusions or recesses on fully inserted contact members is located either on the central plane for the plate or equidistance above and below the central plane. In this way, the stressed resin does not warp the plate.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded view of an interposer assembly;

FIG. **2** is a perspective view of a portion of a plate used in the interposer assembly showing a contact member in position for insertion into an aperture in the plate;

FIG. **3** is a view of the plate shown in FIG. **2** after insertion of the contact member and formation of a solder ball on the bottom of the contact member;

FIG. **4** is a view illustrating sandwiching of the plate between pads on upper and lower substrates;

FIG. **5** is a sectional view illustrating the contact member in the plate;

FIG. **6** is a view similar to FIG. **2** illustrating a contact member with an attached solder ball positioned for insertion into an aperture in the plate;

FIG. **7** is a top view of the contact member illustrated in FIG. **4**;

FIG. **8** is a view like FIG. **5** showing the contact member inserted in a different type of aperture in the plate;

FIGS. **9** and **10** are views like FIG. **8** illustrating different contact members;

FIG. **11** is a view illustrating two different contact members inserted in adjacent apertures in a plate; and

FIG. **12** is a view like FIG. **5** illustrating a different contact member in a plate.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates an interposer assembly or socket assembly **10** for forming a large number of electrical connections between contact pads **12** on the upper surface of lower substrate **14** and corresponding contact pads **16** on the lower surface of upper substrate **18**. The pads **12** and **16** are formed in closely spaced ball grid array rows and columns. The pads on both substrates are arranged in quadrants as shown in FIG. **1**.

Interposer or socket assembly **10** includes a dielectric frame **20** with four rectangular openings **22**. A thin, flat and rectangular interposer plate **24** is mounted in each opening **22**. Plate **24** is injection-molded. A large number of contact apertures **26** extend through the thickness of each plate **24**. The apertures **26** are arranged in closely spaced ball grid array rows and columns to correspond to rows and columns of pads **12** and **16** on the upper and lower surfaces of substrates **14** and **18**. A formed metal contact member **28** is mounted in each aperture **26**. Each contact member **28** establishes an electrical connection between a pair of opposed pads **12** and **16**.

A processor or other electronic component **30** is mounted on the top of substrate **18** with conductors connected to pads **16**. Pads **12** on substrate **14** are connected to other components as required.

Contact member **28** illustrated in FIG. **2** may be stamp-formed or etched from thin, uniform-thickness metal strip stock and may have a thickness of 0.070 mm. Member **28** includes a flat, generally rectangular central portion **32** with opposed, parallel side edges **34**, a formed cantilever contact **36** extending upwardly from the top of portion **32** and solder ball contact **38** extending downwardly from the bottom of portion **32**.

The cantilever contact **36** is narrower than portion **32** and includes a tapered, reverse bend spring arm **40** with a pair of contact points **42** at the upper end of the arm. The contact points may be of the type disclosed in U.S. Pat. No. 6,730, 134. Other types of arms and contact ends may be used as desired.

Contact member insertion shoulders **46** are located at the top of central portion **32** to either side of contact **36**. Solder ball contact **38** includes a solder ball tab **44** at the center of central portion **32**.

Two rounded protrusions or bumps **48** extend outwardly from contact side edges **34** at the bottom of central portion **32**. The protrusions increase the width of the central portion.

Each contact member **28** is inserted into a contact aperture **26** extending through the plate from plate top surface **50** to bottom surface **52**. Contact apertures **26** may be cylindrical about axes perpendicular to the top and bottom surfaces **50** and **52** of flat interposer plates **24** and may have a diameter of 0.650 mm. The size of contact apertures **26** is larger than the solder balls mounted on tabs **44** to allow removal and reinsertion of contacts which have a solder ball attached. Diametrically opposed slots **54** extend into the apertures **26** from top surface **50** a distance slightly below central plane **56**. Central plane **56** is equidistant between and parallel to surfaces **50** and **52**. The slots **54** may have a width slightly greater than the thickness of contact member central portion **32** and may have a depth of 0.800 mm. The bottoms of slots **54** may be spaced apart a distance **58** of 0.850 mm, slightly greater than the width of central portion **32** away from protrusions **48**.

Each protrusion **48** extends a distance out from the adjacent central portion edge **34**. The distance may be 0.050 mm. The maximum width of the central portion **32** at protrusions **48** is greater than the distance **58** between the bottoms of slots **54**. The end or peak **59** of each protrusion forms and extends into an elastically stressed recess **62** in the resin in the bottom of the adjacent slot **54**. The recess extends a distance **78** of 0.006 mm or more into the resin at the bottom of the slot.

In interposer assembly **10**, each plate **24** may measure 6.5 cm by 5.5 cm and may include over 3,000 apertures **26** arranged in closely spaced ball grid array rows and columns. The plate may have a thickness of about 1.27 mm. The plate is injection-molded from a suitable resin which may be a glass-filled liquid crystal polymer. Liquid crystal polymer resins are useful in forming interposer assembly plates **24** because the resin can be injection-molded to form large parts with a large number of very accurately molded through apertures. Additionally, glass-filled liquid crystal polymer resins have high temperature stability and are not deformed when heated to high temperatures required to heat-attach lead-free solder balls on solder ball tabs at the lower ends of contact members inserted into the apertures or during heating and melting of the solder balls and reflow soldering of the tabs to pads on an underlying substrate.

FIG. **2** illustrates a contact member **28** positioned above a supported interposer plate **24** in position for insertion into contact aperture **26**. The contact members **28** are inserted into apertures **26** in the plate using insertion tooling. Insertion of one contact member into an aperture will be described, it being understood that all contact members on the plate are inserted into apertures in the same manner.

Insertion tooling grips contact **36**. Driving surfaces on the tooling engage shoulders **46**. The tooling is then lowered onto the plate to move contact member from an insertion position of FIG. **2** to an inserted position of FIG. **5**. The driving surfaces on the tooling move shoulders **46** down flush to top surface **50**. The central portion **32** of member **28** is aligned with opposed slots **54** in aperture **26** so that the edges of the central portion extend into slots **54**, and protrusions **48** engage and are moved down the bottoms of the slots to the fully inserted position shown in FIG. **5** where the protrusions are located on central plane **56**.

During insertion of each contact member **28**, the protrusions engage the resin at the bottoms of slots **54** as they move from top surface **50** down to the fully inserted positions on plane **56** shown in FIG. **5**. The bands **58** are elastically and plastically stressed as the projections move down to center plane **56**. After passage of the projections, the deformed resin in the bands partially returns to its initial position, with the exception that the projections **48** extend into deformed recesses **62** at plane **56**. The elastically stressed resin engages protrusions **48** to form connections holding the member in the aperture and resist forces that would unseat the contact member from the installed position.

Dimensional tolerances inherent in manufacture of contact members **28** may vary the spacing between projections **48**. The resin in plate **24** is deformed by projections **48**. The projections extend into the resin a distance, which may be 0.006 mm or more, so that during insertion of the contact member, the resin in each elastically deformable band **78** is compressed. The inserted member is not physically connected to the plate away from protrusions **48**.

In the event contact member **28** is withdrawn from aperture **26**, protrusions **48** are moved upwardly along bands **58** and deform the resin in the bands. Insertion of a new contact member into aperture **26** again deforms the bands as protrusions **48** are moved down to the insertion position at plane **56**, as previously described.

Insertion of a large number of contact members **28** in each plate **24** compresses and stresses the resin in the plate at recesses **62** throughout the plate. The resin remains elastically stressed to hold the contact members in place in the plates. The stressed resin is located at the center of the plate thickness, on plane **56** and does not create a bending force which would warp the plate. The plate retains its molded flat shape despite insertion and retention of a very large number of contact members where the contact members are retained in the plate by elastically stressed resin. Stress bending of the plate is highly undesirable as it shifts the vertical positions of contacts **36** and **38** which adversely affects solder ball bonding, soldering of the balls to pads on substrate **14** and establishing pressure electrical connections with the pads on substrates.

As illustrated in FIG. **5**, contact member **28** is inserted into aperture **26** with shoulders **46** at top surface **50** and shoulders **64** at the bottom of central portion **32** closely adjacent to plate stop surfaces **60** at the bottoms of slots **54** to prevent insertion of the contact member below the position shown in FIG. **5**. Over insertion would move protrusions **48** below plane **56** with risk that the stressed resin could warp plate **24**. Connections with pads on substrates **14** and **18** could be impaired.

After all contact members **28** have been positioned in apertures **26** in plate **24** as illustrated in FIG. **5**, spherical solder balls **66** are attached to the solder ball tabs **44** extending below plate bottom surface **52**. The solder balls are attached to the tabs using known technology. The LCP resin in plate **24** is not affected by the high temperature required to attach lead-free solder balls **66**.

Interposer plates **24**, with contact members inserted in apertures **26** and solder balls **66** on tabs **44**, are positioned in the four quadrant openings **22** in frame **20**. The frame, with the interposer plates, is accurately positioned on lower substrate **14** with each solder ball engaging a pad **12** as illustrated in FIG. **4**. The solder balls are then heated to melt the solder balls and, upon cooling of the solder, form individual reflow solder connections between pads **12** and contact members **28**.

After soldering of the contact members **28** in assembly **10** to the pads **12** on lower substrate **14**, upper substrate **18** is positioned above assembly **10** with upwardly extending alignment members **68** on frame **20** engaging corresponding openings and recesses **70** on the substrate to locate the substrate on the assembly accurately and assure that the contact points **42** of each contact member are located immediately under an appropriate pad **16** on the lower surface of substrate **18**. The substrate **18** and processor **30** are then moved down toward frame **20** so that the contact points **42** on the contact members **28** engage the pads on substrate **18**, the cantilever contacts **36** are resiliently deflected down toward plates **24**, and the points **42** move a distance along the pad to form reliable, wiped electrical connections with the pads. FIG. **7** illustrates that when the springs arms **40** are compressed, the contact points **42** move a distance **72** from start position **74** to end position **76**. The upper substrate **18** is secured in the lowered position to maintain electrical connections between pads **12** and **16** on substrates **14** and **18**.

The interior diameter of cylindrical contact aperture **26** is larger than the diameter of the solder ball **66** formed on contact **38**. This means that, if necessary, a defective contact member **28**, with or without an attached solder ball, can be withdrawn from plate **24** by physically engaging contact **36** and pulling the member up and out of the aperture. Protrusions **48** are moved upwardly and out from slots **54** without physical injury to the resin, as previously described. The elastically stressed resin expands.

Another contact member **28**, with solder ball **66** attached to tab **44**, is then inserted into the empty aperture **26**, as previously described, to replace the defective contact member. See FIG. **6**. The protrusions **48** on the replacement contact members extend into elastically stressed recesses **62** in the plate to retain the contact in the plate as shown in FIG. **5**. Solder ball **66** moves freely through aperture **26** to the bottom of the plate.

FIG. **8** illustrates interposer plate **80** which is like plate **24** with the exception that contact apertures **82** are cylindrical and do not have opposed slots **54** as used in apertures **26**. Contact members **84**, which may be like members **28**, have rectangular central portions **86** and opposed protuberances or bumps **88** at the bottom edges of the central portions. Cantilever contact **90** extends above the top of portion **86**. Solder ball contact **92** extends below the bottom of the central portion and may be a solder tab **94**.

The width of the central portion **86** at protrusions **88** is slightly greater than the diameter of aperture **82**. During insertion of contact member **84** into aperture **82**, tooling inserts the contact until shoulders **96** are flush with the top of plate **80**, as previously described. Protrusions **88** compress resin bands **98** extending along opposite sides of the aperture **82** from the top of the aperture to the bottoms of the bands during insertion. As illustrated in FIG. **8**, when contact member **84** is fully inserted, protrusions **88** are located on central plane **100**. Bands **98** may have a thickness of about 0.006 mm, like bands **78**. The compressed resin at protrusions **88** holds contact member **84** in aperture **82**, as previously described. The stressed resin in plate **80** at the recesses formed by protrusions **88** is located on central plane **100** and does not warp plate **80**.

Solder balls are attached to solder tabs **94**, as previously described. Individual contact members **84** may be removed from aperture **82** for replacement, as previously described.

FIG. **9** illustrates an interposer plate **102**, like plate **80**, with cylindrical contact apertures **104**. Contact member **106** is similar to prior-described contact members and includes a generally rectangular central portion **108**, a cantilever contact **110** extending upwardly from the top of portion **108**, and a solder contact **112**, which may be tab **114**, extending down from the bottom of the central portion. Central portion edge **116** is flat and has a sliding engagement with the adjacent wall of aperture **114**. Two spaced protrusions **120** are located on opposite edge **118** equidistant above and below central plane **122**.

Resin in band **124** is compressed during insertion of member **106** into aperture **104**. Lower protrusion **120** compresses and stresses the resin in upper and lower bands **124** and **126** during insertion. Upper protrusion **120** compresses and stresses the resin in upper band **124** only. The elastically stressed resin in the recesses at the protrusions holds member **106** in place in plate **102**.

The two protrusions **120** are located equidistance above and below central plane **122** so that the stressed resin at the recesses formed by the protrusions **120** is equidistant above and below the plane and does not warp plate **102**.

FIG. **10** illustrates interposer plate **128** which is like plates **80** and **102**. Cylindrical contact apertures **130** extend through plate **128**. Contact member **132** is like contact member **106** with the exception that a pair of protrusions **134** is provided on each edge of central portion **136**. Each pair of protrusions **134** is located equidistant to either side of central plane **138**. During insertion of contact member **132** into aperture **130**, upper protrusions **134** compress and stress the resin in upper bands **140**, and lower protrusions **134** compress and stress the resin in both upper bands **140** and lower bands **142**, as described in connection with insertion and withdrawal of contact member **106** from plate **102** illustrated in FIG. **9**. The elastically compressed resin holds the protrusions in place in the plate. The pairs of protrusions on each side of the central portion compress resin at locations equidistant above and below the central plane so that the elastically stressed resin does not alter the shape of plate **128**.

FIG. **11** illustrates interposer plate **144** having adjacent apertures **146** extending through the thickness of the plate. Apertures **146** may be located in the same row or column of apertures in the ball grid array of apertures on the plate. Alternatively, the apertures may be located in adjacent rows or columns or in a row and a column.

Contact member **148** is positioned in one aperture **146**, and contact member **150** is positioned in the adjacent aperture **146**. The contact members **148**, **150** are related to contact member **84** illustrated in FIG. **8**.

Contact member **148** includes a rectangular central portion **152**, similar to portion **86**, with the exception that portion **152** extends down from plate top surface **154** past central plane **156** and includes protrusions or bumps **158** extending outwardly from the edges of the central portion located a distance below the central plane.

Contact member **150** includes a rectangular central portion **164** with protrusions **166** extending from opposed sides of the central portion and located a distance above plane **156**. Protrusions **166** are located a distance above plane **156** equal to the distance protrusions **158** are located below plane **156**. Cantilever contact **168** is like contact **90**. Solder contact **170** is like contact **92**.

Contact members **148** and **150** are inserted into apertures **146** as previously described. The bumps or protrusions **158** and **166** extend into the resin at the opposite sides of the apertures and deform resin bands **172**. Bands **172** for contact member **148** extend from top surface **154** past central plane **156** to projections **158**. Bands **172** for contact member **150** extend from top surface **154** down to projections **166**. Projections **158** and **166** on both contact members elastically compress resin at the projections. The compressed resin holds the contact members in plate **144**, as previously described.

Protrusions **158** and **166** are located equidistance above and below central plane **156**. The two contact members **148** and **150** are located close together on plate **154**. The plate includes a large number of paired contacts **148**, **150** with protrusions **158**, **166** which compress the resin in the plate at equal distances above and below the central plane. The result is that the stresses in the resin above and below the plane **156** are equal so that the stresses do not deform the flat plate **144**.

Cylindrical apertures extend through the plates of FIGS. **9**, **10** and **11**. Cylindrical apertures permit insertion of contact members at a desired angular orientation in the apertures around a vertical axis.

FIG. **12** is similar to FIG. **5** and illustrates an interposer plate **200**, similar to plate **24**, with contact member **202** removably mounted in contact aperture **204**. Plate **200** is like the previously described plates and includes a large number of apertures **204** arranged in a ball grid array rows and columns. Contact **202** may be formed from the same thickness metal strip stock used to form contacts **28**.

The contact member **202** includes central portion **206**, like central portion **32**, upper cantilever contact **208**, like contact **36** and lower solder ball contact **210**, like contact **38**. The contact aperture **204** may be cylindrical.

The contact aperture **204** includes an integrally molded pair of opposed resin protrusions **212** located on the central plane **214**. Plane **214** is located equidistance between top surface **216** and bottom surface **218** and is parallel to the surfaces.

The central portion **206** of contact member **202** includes opposed side edges **220**, like edges **34**, and a recess **222** on each edge located at plane **214**. The resin in protrusions **212** is compressed in recesses **222**. When molded, the protrusions **212** extend a distance further away from the aperture than as illustrated in FIG. **12**.

The protrusions **212** may be located on an interior protrusion ring extending around the circumference of aperture **204**. Protrusion rings facilitate insertion of members **202** in the apertures at a desired angular orientation in the aperture around a vertical axis.

Contact members **202** are inserted into apertures **204** in plate **200** from top surface **216**, as previously described. Tooling engages insertion shoulders **224** which are flush with the top surface **216** when the contact members are fully inserted into the apertures.

During insertion of the contact member, rounded corners **226** at the bottom of edges **220** engage and compress protrusions **212** as the side edges **220** move past the resin in the protrusions. The protrusions expand into rounded recesses **222** which are located above corners **226**. With the contact members in the position shown in FIG. **12**, the resin in protrusions **212** is elastically compressed and tightly engages the recesses **222** to form physical connections securing the contact members in the plate and to prevent dislodgement of contact members from the aperture. The contact members **202** are inserted into apertures **204** by elastically compressing the protrusions **212** without injury to the protrusions. The corners **226** and recesses **222** are rounded to prevent injury to the resin.

The diameter of aperture **204** may be reduced to provide slots, similar to slots **54**, extending from protrusions **212** to the top surface **216**.

A contact member **202** may be withdrawn from plate **200** as previously described by gripping contact **208** and pulling the contact member from the aperture. Withdrawal of the contact member elastically compresses the protrusions **212**. Upon withdrawal, the protrusions expand to their uncompressed shape. Another contact member may then be inserted into the aperture, as previously described.

Cylindrical apertures extend through the disclosed interposer plates. Uniform cross section cylindrical apertures can be spaced together closely to facilitate dense mounting of contact members on the plates. The apertures may have other shapes and may have non-circular interior cross sections if desired.

The disclosed contact members have a spring contact on one side of the plate in which the member is inserted and a solder contact on the opposite side of the plate. After insertion of contact members, the plates are processed to attach solder balls to the solder contacts and are then soldered to pads on an underlying substrate. If desired, the angled cantilever arms on the top of the contact member may be replaced by other types of contacts.

The contact members **28**, **84**, **106**, **132**, **148**, **150** and **202** include depressing portions in the form of protrusions or recesses which engage and elastically compress resin in apertures to form connections mounting the contact members in the plates.

Contact members are inserted into the plates, compress resin in the plates and are held in the plates by the compressed resin. The members can be withdrawn from the plates and replacement members can be inserted and are held in the plates by compressed resin. Insertion of a member may slightly wear or abrade the softer resin but does not prevent withdrawal of the member, insertion of a replacement member and compression retention of the replacement member in the plate.

If desired, the solder contacts at the bottom of each contact member may be replaced by spring contacts, such as a spring arm for resiliently engaging an underlying pad without solder connection, or a contact abutment for engaging an underlying contact pad or other types of contacts.

Accordingly, the disclosure is not limited to interposer plates where the inserted contact members include cantilever contacts, solder contacts or tabs but includes plates with contacts for forming other types of electrical connections with pads above and below the plate.

What I claim as my invention:

1. An interposer assembly for forming electrical connections between contacts on opposed substrates, the interposer assembly comprising, a flat plate formed of thermoplastic resin, the plate having opposed flat and parallel top and bottom surfaces and a uniform thickness, a central plane located equidistant between the top and bottom surfaces, and a plurality of contact apertures extending through the thickness of the plate, said apertures arranged on the plate in intersecting rows and columns, each aperture having opposed aperture walls and an elastically depressed recess in an aperture wall; and a plurality of contact members, each contact member having a substantially flat central portion in a contact aperture, an upper contact portion extending upwardly from the central portion toward the plate top surface and a lower contact portion extending downwardly from the central portion toward the plate bottom surface, the central portion having opposed side edges engaging the aperture walls and one or more rounded contact protrusions on a first side edge, each protrusion extending a distance into an aperture wall and elastically stressing resin in the aperture wall to form the recess in the aperture wall and exert a stress force on the plate; the total of the stress forces exerted on the plate by the contact protrusions being essentially zero at the central plane so that the plate is substantially flat.

2. The assembly as in claim 1 wherein the plate has a thickness of about 1.27 mm.

3. The assembly as in claim 2 where in the apertures are cylindrical and have a diameter of about 0.65 mm.

4. The assembly as in claim 1 wherein each contact member includes one or more rounded protrusions on a second side edge, each such protrusion engaging and elastically stressing the resin in an aperture wall.

5. The assembly as in claim 4 including opposed slots in each contact aperture, each slot extending to one side of the plate, said contact member side edges in said slots.

6. The assembly as in claim 1 wherein said apertures are generally cylindrical.

7. The assembly as in claim 6 wherein each contact member has a uniform thickness and includes a spring contact.

8. The assembly as in claim 7 wherein each aperture has a diameter of about 0.65 mm, and each contact member has a thickness of about 0.07 mm.

9. The assembly as in claim 8 including a solder ball on each contact member.

10. The assembly as in claim 1 wherein each contact member includes an insertion surface and a shoulder, each aperture includes a stop surface aligned with said shoulder and facing the top surface, each shoulder is flush with the top surface of the plate, and the shoulder is adjacent the stop surface.

11. The assembly as in claim 1 wherein said contact protrusions are either located on the central plane or are located on opposite sides of the central plane.

12. An assembly for forming electrical connections between contacts on opposed substrates, the assembly comprising a flat plate formed from molded thermoplastic resin, the plate having a uniform thickness, parallel top and bottom surfaces and a plurality of contact apertures extending through the thickness of the plate between the top and bottom surfaces, said apertures arranged in closely spaced rows and columns, each aperture having opposed aperture walls and a first elastically compressed retention portion extending into on an aperture wall; and a plurality of metal contact members, each contact member comprising a substantially flat central portion with side edges, an upper contact extending up from the central portion, a lower contact extending down from the central portion, and a first depressing portion on a side edge, the central portion in a contact aperture and engaging the opposed aperture walls, the first depressing portion engaging and extending into the retention portion to maintain the retention portion elastically compressed and deformed outwardly of the aperture, the first depressing portion and the retention portion forming a first physical connection holding the contact member in the aperture and to permit non-destructive withdrawal of the contact member from the aperture wherein each depressing portion is concave.

13. The assembly as in claim 12 wherein each retention portion is convex.

14. The assembly as in claim 12 wherein each aperture includes an elongate elastically compressible band extending from the retention portion to one plate surface.

15. The assembly as in claim 12 including a slot in each aperture, a band at the bottom of each slot.

16. The assembly as in claim 12 wherein each contact member includes a second depressing portion, said first and second depressing portions on opposite side edges of the central portion, and each aperture wall includes a second elastically compressed retention portion; said second depressing portions and said second retention portions forming second physical connections holding the contact members in the apertures.

17. The assembly as in claim 12 wherein the depressing portions are located either on or equally above and below a plane equidistant between the surfaces.

18. The assembly as in claim 12 wherein each contact member includes an insertion surface and a stop surface adjacent a shoulder in an aperture.

19. An assembly for forming electrical connections between contacts on opposed substrates, the assembly comprising a flat, uniform thickness plate formed from molded thermoplastic resin, the plate comprising parallel top and bottom surfaces and a plurality of contact apertures extending through the plate between the top and bottom surfaces, the contact apertures arranged on the plate in intersecting rows and columns, each aperture having opposed aperture walls; a plurality of metal contact members in the apertures, each contact member comprising a central portion having side edges, an upper contact extending up from the central portion and a lower contact extending down from the central portion, the central portion in a contact aperture with the side edges engaging opposed aperture walls; and means for resiliently retaining the central portions of the contact members in the contact apertures by elastically stressing resin in the aperture sidewalls without bowing the plate and for nondestructive insertion of the central portions into the contact apertures said means including an elastically deformable strip of thermoplastic resin on one side of each aperture.

20. The assembly as in claim 19 wherein said means includes an elastically deformed recess in each contact aperture and a contact protrusion on each contact member, the contact protrusions extending into the recesses.

21. The assembly as in claim 19 wherein the means includes an elastically deformed protrusion in each contact aperture wall and a contact recess on each contact member, the recesses surrounding and elastically stressing the protrusions.

22. The assembly as in claim 19 wherein said means are located either on a plane equidistant between the top and bottom surfaces of the plate or equidistant above and below the plane and the plate is flat.

23. A method of mounting metal contact members in a dielectric plate, comprising the steps of:

a) providing a flat plate formed of dielectric resin and having a uniform thickness, opposed, parallel top and bottom surfaces and a plurality of contact apertures extending through the thickness of the plate with the apertures arranged on the plate in intersecting rows and columns;

b) providing a plurality of metal contact members with each contact member having a substantially flat central portion and upper and lower contact portions;

c) inserting a contact member in into each contact aperture central portion to elastically and non-destructively compress resin in the aperture wall and form a resilient physical connection between the plate and the central portion which retains the inserted central portion in the aperture and exerts a stress force on the plate; and

d) locating the elastically compressed resin at each physical connection either on or to either side of a central plane equidistant between the plate top and bottom surfaces to prevent warpage of the plate by the stress forces and

e) elastically and non-destructively stressing a band of resin in each aperture during movement of each contact member into the aperture.

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